tions. All the more welcome will be this pleasantly written volume, which gives a far brighter picture of the Republic and its prospects than its most sanguine sympathisers may have anticipated. Since the expulsion of the French in 1867, profound peace has prevailed both at home and abroad, interrupted only by a few feeble and aimless pronunciamientos in the years 1868 and 1869; signs of moral and material progress are everywhere perceptible; security for life and property is being extended from the capitals to the remotest districts of the several states; the whole country is already covered with a network of railways connected in the north with the United States system, and affording several alternative routes between the Atlantic and Pacific Oceans; lastly, the Liberal party, which has guided the destinies of the Republic for over twenty years, has succeeded in establishing free institutions on a firm basis. "I have every confidence," writes our author, "that the favourable terms in which I have spoken of the country will not hereafter be found to be exaggerations; that my ideas as to the future prosperity of Mexico being early realised are true, and that such ideas are held by most of its leading men." And he adds that the time has come for England to bring about "a reconciliation with a country, in whose aid her influence and power could be so beneficially exerted" (p. 259).

The contents of this work, which is sumptuously illustrated by no fewer than fifty-six coloured and other plates from sketches by the author, are extremely varied, special chapters being devoted to the present state of the capital and surrounding districts, to the public institutions, the Roman Church, Protestant missions, trade, manufactures, farm life, the Pachuca silver mines, antiquities, the ruins of Teotihuacan, the remarkable limestone caves of Cacahuampila, Popocatapetl, and many other topics of general interest. During the ascent of Popocatapetl, the traveller ascertained that, according to the latest survey, the edge of the crater was 19,000 feet above sea-level, the usual estimates being 17,850 to 17,880, and that the peak still rose 1000 feet higher. Should these calculations be confirmed, Popocatapetl will again take its place as the culminating point of North America, a position from which it had recently been deposed by Mount St. Elias on the Alaska coast.[1] On the same occasion another curious discovery was made. General Uchoa, present owner of the crater and its rich sulphur deposits, told our author that the eruption of 1521, as described by Diego Ordaz, one of Cortes's captains, must have been due to some misapprehension. All geologists who have lately visited the crater, or who have examined specimens of its minerals, are now convinced that no eruption can have taken place for the last 10,000 years. This is a great confirmation of the opinion now generally entertained that the underground energies diminish steadily in vigour as we proceed from the Southern Cordilleras, through Central America, northwards to the Anahuac tableland. The financial condition of Mexico is described, contrary to the current impressions, as far from hopeless.

Of the numerous illustrations a large number are occupied with curious little clay heads, obsidian knives, stone pestles, arrowheads, and other objects found amongst the debris of the Teotihuacan ruins and elsewhere. There are also excellent reproductions of the famous Aztec Calendar and sacrificial stones, of a beautiful vase from Teotihuacan, of Teoyamiqui, the goddess of death, and of an exquisite vase of Centeotl, or the Mexican Ceres, a perfect gem of Aztec art. Many of the objects brought home by the traveller have been placed in the hands of Mr. Franks of the British Museum, and are no doubt ultimately destined to enrich the Christy collection.

A. H. K.

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[1] On the British Admiralty charts this mountain is marked 14,800 feet, but by the late United States Survey it was raised to 19,500 feet.

LETTERS TO THE EDITOR

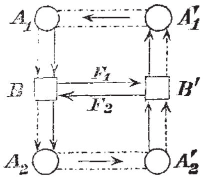
[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.

[The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to insure the appearance even of communications containing interesting and novel facts.]

The Matter of Space[1]

II.

In the aggregations of points which form ponderable bodies, other means exist of suppressing the effects of the points' attractions for each other than the simple counteracting forces of the above figure. Clausius's equation of stationary motion in fact informs us that this will take place when there is no exertion of tractive moment, or no total instantaneous sum of motor-couple actions in the system. This simply appears to imply that the pair of orbs A_1 A_2 and the pair A_1' A_2' are in that case no longer independent of each other in their transference and counter transference of motor energy, but that the twofold action of such energy is then a self-neutralising one; or in other words that the energy given off at A_2 passes on to A_2'; and that discharged at A_1 is taken up by A_1; so that in the case where B B′ are in stationary motion, or combine to form a "sphere" of two gravitating points, or again where many such points collected together form a permanent ponderable body, orb-couples intervene between the otherwise free extremities, $A_1'A_1$ and A_2A_2' of the two ether systems (in the directions shown by arrows in the figure), and bind them together conservatively by an endless circuit of motor energy through the ether-orbs, while a similar endless flow of ordinary momentum through the ponderable channels of the system in the meantime constitute also the usually recognised internal, gometrical, or "lost" forces of such a permanent aggregation, "sphere" or "body" of ponderable matter.



This subjection of two or more baric points B B′ &c. to the condition of stationary motion, as the bond of neutrality of "lost" geometrical or "internal" forces between them differs therefore from the case before supposed of absolute suppression of all interforce between them in this, that when (in the latter case) the motions of the points B B′ &c. are absolutely free and entirely exempted from disturbing force action, the motor-vigours of the couplets A_1A_2, $A_1'A_2'$&c. of the ether-orbs in permanently bound binary attendance upon the baric points B B′, &c., respectively, will then also be equally exempt and free from disturbing actions of any other orb-couples upon them, than those only by which they are dually and counter-equally bound to each other through the channels of their respective baric centres B B′, &c.

Throughout the whole of a baric point B or B_1's state of undisturbed rest or motion, the ether-couplet attached to it is constantly transmitting from one of its ether-orbs to the other a ceaseless flow of undirected energy, or it is etherially exercising a ceaseless undirected horse-power, whose supply of energy is drawn from and is returned again without mal-destination to the universal ether's general stock of energy, if the meaning of the principle of conservation of energy in this case may be said to be that, for the entire sum of all its parts, the universal ether's whole stock of energy never undergoes any alteration. We may next consider also the case where the interforces between baric points are not entirely absent, but may present us with a resultant algebraic sum of any number of interforces, instead of with a neutral sum only of two equal and opposite ones. Although in that case there is no counter-equality between the motor-couples which act on the ether cortege A_1 A_2 &c. of each baric point B or B′ &c. yet if the motions of these latter points are subjected to no condition of stationariness under the influence of the forces acting on them we may yet recognise the universal ether's whole stock of energy as being the source and destination of all the flows of undirected energy exerted by the collective cortége's couples, if we assume for the whole of the ether together the same obedience to the law of conservation of energy as before, because, for each one of the interforces between B and some other baric point B′, and therefore in the sum of all such mutual forces and points paired with B to produce them, the orb-couples at A_1 A_1' which yield the force F_1 are exactly counter-equivalent to each other, and so will abstract from such a general stock of energy just as much at one of their points of action A_1 or A_1' as they restore to the same general stock of their energy requirements at the other one.

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[1] Continued from p. 460.

The presumption here used that the undirected energy funded and effunded by the motor-couples acting on the ether-retinues of the reacting baric points, belongs to an invariable stock of that description of energy residing in the universal ether as a whole, and that it is not extracted from and rendered up to any other imaginable sources, or in other words the theory of the conservation of motor energy in the universal ether by all the motor orb-couples together which are in action in it, acquires an important meaning, when we recur again to the nature, as above explained, of the condition to which these orb-couples are subjected when they act upon the ether-retinue of a collection of baric points which compose a "sphere" or body, or which are together in stationary motion. The description already given of this case informs us that when the state subsists, the simple sum of all the motor actions or tractive couples on the body's retinue of aërilians [1] is either nil at all times instantaneously, or, when it is a periodic sum, its average value for a time-period or recurring time-cycle of its changes is so. No instantaneous resultant can be formed at all, if the sum's value is perceptibly periodic, and it is not in our power to say whether ether orbs of aërilian points originally differentiated from weighty material points (or whether those points themselves) yield sums which have periodic or instantaneous resultants; it belongs to a strict examination of the subject to pronounce and illustrate the rules by which stationary or periodic resultant sums can, in combinations of orbs or aërilian parts, afford by proper means either periodic or stationary resultant actions on a collective aërilian assemblage. The mode of combination of such actions on subordinate parts into a resultant action of one or both kinds on a united group which they compose is certainly not a hopeless problem, when its character is once regarded as the essential problem of etherial mechanics. What free or unbound ether may exist besides the ether enrolled in the retinues of ponderable matter, and what actions these free and enrolled portions of the ether may have upon each other, and separately or together upon the originally sundered multitudes of matter composing the ponderable parts of gravitating bodies, so as (with time as another element of the reactions) to explain the gradual process of condensation which appears to be a perfectly regulated progressive principle of material economy, are all questions which, by a closer discussion of the surmises here explained and indicated, may without doubt be certainly expected to follow from their careful consideration, in due course. But as the phenomenon of stationary motion is shown by Clausius's equation (which states its condition) to be at least a rigidly true absence of average total tractive moment in a system which presents it, when the average is a time-average taken over a sufficiently long fixed or over a proper repeatedly recurring term or movable interval of time, and since, to senses incapable of discriminating exceedingly minute quantities, this time-average becomes an instantaneous quantity when the time-term for which it is reckoned diminishes without limit, a conclusion may be readily drawn from this which will fairly justify us in accepting the presumption used above, that the instantaneous effects of individual motor-couple actions are conserved in the universal ether as a whole. For we are unable to discriminate *what* periodic variations the sum of these effects may or *may not have* in their total value for the universal ether; and we have therefore exactly the same grounds for regarding the instantaneous effects of all motor-couples as being instantaneously conserved by the occult fluctuating terms or periods of the universal ether, as we have for viewing them as instantaneously conserved (so as to give a sensibly stationary zero resultant sum) throughout the parts of a ponderable body's mass in which we cannot detect any periodic motion, or any perceptible vibration.

A bent bow, when its string is released, a soap-bubble or an air-gun's charge, when they give way and burst, or a bubble of hydrogen and chlorine gas mixture when an active light-ray strikes it, ignition of a train of gunpowder by hot iron, or of fire-damp in a safety lamp, of gases and gold leaf by the electric spark, are instances, if we could penetrate the process, of suddenly infringing by a forced vibration the gradually attained subsidence of all perceptible periodicity in a system's inner motions, with instant disintegration for its consequence of the stationariness of the motor-actions of its parts. A little universe in effigy has collapsed, leaving to the universal ether the task of saving and storing up, by means of individual free motor-couples, the vibrations let loose, and of so modelling into something else the scattered fragments.

But on the other hand the resisted jet, as well as the shutting of a water-pipe or steam-boiler valve, the swing of a hammer as well as its stroke on a rock or bell, directed radiations of all kinds as well as their radiometer-like interceptions, the steadily resisted flow as well as the breaking or making of an electric current, conduction between bodies of a steady flow of heat, sound, and all perceptible horse-power exercises of motor-vigour's effective, or unreversible operations, can only be conducted (as the ether does conduct such effective works there conservatively) by the individual periodic actions of unbalanced motor-couples acting on some free-coursing ether-orbs or orb-clouds forming equally free-coursing heavy bodies' retinues. These all rely directly on the universal ether's store of motor energy to maintain in their isolated severance (and in that of the free-coursing bodies also) from other works' and matters' motions a constant conservation of their unreversible motor-activities' effects.

This view of the ether's function as a whole to conserve the individual effects, both of primordial and of resultant motor-couples on ether aërilians and orbs and clouds, whether those couples' intensities are stationary, or fluctuate and vary in any periodical or unperiodical manner, is the second maxim above noted, to be kept in view along with that of description of couples' intensities as a time-rate of a certain kind of energy, in discussing the properties, or the etherial mechanics, of motor-couples' balanced and unbalanced actions. The maxim, as thus laid down, also cautions us against confusing the kind of *instantaneous* energy effects of motor-couples, which the ether conserves as a whole, with any periodically *term-averaged* semi-mean square of a collection of particles' rhythmically fluctuating velocities, or with any temporary or enduring "peræval sum," as it may be called, of the collection's total undirected energy, since the instantaneous undirected sum thus obtained, is not really instantaneous as long as the length of the term or period over which the average is taken is a perceptible and measurable one. The resultant quantity whose effects the ether conserves at every instant, on any individual aërilian assemblage, by a total sum of counter-equivalent quantities acting on other aërilian assemblages or aërilians is the sum (treating every aërilian as of the same inertia $m = 1$)

$$\Sigma \frac{d}{dt}\left(r\frac{dr}{dt}\right) = \Sigma\left(Rr\right) + \Sigma\left(v^2\right);$$

where, for a single aërilian, r is a vanishingly small distance between at least two parts of which it must consist, and for groups of aërilians the sum also includes, under the general symbol r, the distance between centres of every pair of aërilians possessing, relatively to the assemblage's centre of inertia (just as the aërilian parts do relatively to their aërilian centres), counter equal accelerations, $R, -R$. We are not at liberty in applying the equation to include in its sum any other distances and accelerations, nor any other velocities v, of the aërilians' parts and centres than these barocentric ones, relative to centres of inertia included in the given system, because as an equation of couples having no truth or meaning, except in virtue of its composition of pairs of quantities (so furnished by pairs of inert points contained in the system as to be independent in its sum of the origin of reference used in its formation), all distances, velocities, and accelerations of the given system's centre of inertia cannot form part of the equation conformably to its physical use and applications, but must form part of physical actions in some other system, of which the given assemblage and its centre of inertia forms one individual member.

It is this necessary view of the above equation of stationary motion drawn from such views as those here offered of its physical interpretation, which obliges us to regard the simplest aërilian point of the ether as consisting of at least two parts; and this assumption agrees with the dual view of the ether's nature taken by Professor O. Lodge in his address on the "Functions of the Ether" (NATURE, vol. xxvii. p. 328), while this system also explains the kind of conservation which has been noticed independently by Dr. G. Lippmann and Professor S. P. Thompson[1] as characterising the phenomena of electricity, and the close resemblance which not only exists between the processes of conduction of heat and of electricity, but also, as noticed by the former writer, between the laws of electrical potential and the thermal principle of Carnot's law.

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[1] Those entering into the baric body's actual composition may be left out of the enumeration, since this body's baric motions being themselves (all taken together) stationary, they satisfy the equation of condition identically; and in general instantaneously, unless a common periodic motion is given to the baric points.

It seems scarcely probable that so many converging views can be all fallacious, and ingenuity may without doubt be spent with profit and advantage in further attempts to adapt and reconcile some comprehensive theory of the ether's properties, of a mechanical description, to embrace in a common review all the multiplicity of remarkably analogous laws, which physics in its various branches at present offers to our contemplations.

If the description which precedes of a connected outline of such a system of synoptic views has extended to a much greater length than I was originally prepared to offer as comments on Mr. C. Morris' communication, it is because the logical developments which I have repeatedly found them to admit of induced me to try to establish them on a satisfactory foundation. In many trials, moreover, of their applications, I have met with such frequent proofs of the validity of some such general principles as those here indicated, that the results to which they have easily conducted me in numerous directions, are in general so accordant with those which Mr. Morris has skilfully reviewed, that, save in the small divergence between us, upon which I have dilated, in the main principles adopted for explaining them, Mr. Charles Morris's and my views of the properties and laws of motion, of the distribution of the "Matter of Space," and of the mechanical behaviours of "motor-vigour," are for the most part only *variæ lectiones* of each other. A. S. HERSCHEL

Newcastle-on-Tyne, February 10

P.S.—It will perhaps serve to correct some misconceptions which, although they were not intended to be produced, may yet not impossibly have arisen from the form of defective reasoning, which at some few points of this letter's descriptions it has been unavoidably necessary to introduce, to notice in recapitulation that it formed at the outset no part of its main object to define and represent exactly the extremely complicated part which (at least in combinations of its periods) it is evident that time discharges in determining the operative efficacies and strengths of motor-couples, in exerting "vigour" of undirected motion. With a well-grounded geometrical substructure, there need be no occasion to entertain a doubt that the first principles at least of time's use in definitions of the actions and effects of wrests or motor couples will be easily identified and laid down with all the precision and accuracy needed for purposes of their mathematical applications.

The principal object, however, here aimed at and sought to be attained has not been to offer such an exact description of time's relations of form and economy to the different states of action and repose of undirected motion (which do not actually admit of successful discussion without much more abstract elementary conceptions than those ordinarily recognised of geometrical principles), but simply as a preliminary step towards this question's future surer treatment, to point out clearly and plainly the distinctive and peculiar character of undirected motion's space-relations.

This kind of motion, it has been endeavoured to explain, consists in change of magnitude of a certain ratio index, ϕ, of tractional configuration between collocated points. In the capacity of a ratio-index ϕ very closely simulates, in its algebraical and geometrical properties, all the analogous properties of angles. But it differs from them in this important particular, that it possesses no directional qualification. For a crank-arm's description of angle at once assigns the plane of the crank's revolution, and this plane has direction; but extension of a connecting-rod is a ratio which affects the rod's length equally in all positions, without giving rise in so doing to any new direction.

On the other hand, neither motion in angle nor in traction-index can by their unaided to-and-fro presence in a crank or connecting-rod give backward and forward motion to a piston or piston-rod, but only by virtue of certain constraints involving the properties in one case of trigonometrical, and in the other case of hyperbolic, sines and cosines. It is probably because changes of angle are, like the changes of the angle's sine which result from them, directed quantities, that the relations of angle-variations to changes of coordinate lines by means of trigonometrical ratios is a familiarly applied and well-established theory. But no such theory having the same scope and extent of application connecting changes of coordinate lines with variations of the ratio-index ϕ, by means of hyperbolic sines and cosines, and showing what necessary conditions directed geometrical quantities (including angle) *must satisfy* to make a fixed law of hyperbolic connection with the undirected quantity ϕ have any possible existence, has yet been brought into general notice and acceptance.

But that the directed and undirected geometrical quantities do satisfy and fulfil such a condition, and that the fixed law of connection between them does actually exist, there is sufficient evidence to assure us in the consistency with which such reasonings as those which Mr. Morris has produced, and which I have tried to base on that geometrical assumption, represent correctly a very large array of physical phenomena. Forming therefore, as the undirected quantity ϕ does, a position-scale in space, of whose possession of certain distinctive and special geometrical and physical properties no theoretical employment has yet been made, and no sufficient proof of satisfactory evidence has, in fact, heretofore been produced, no excuse, it is opined, for hyperbole or figurative use of speech need be presented, for describing the new quantity, as it was termed in a former part of this letter, as a new position-scale of interspheral, ethereal, or aërilian motions foreign to and independent of our ordinary graphic field of space.

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[1] NATURE, vol. xxiv. p. 140; and pp. 78, 164.

Mr. Stevenson's Observations on the Increase of the Velocity of the Wind with the Altitude

I AM sorry if I took Mr. Stevenson too literally when I understood his remark, "great heights above sea-level," to mean *absolutely* great heights; but I certainly think the phrase is extremely liable to such interpretation, and as no superior limit was assigned, I naturally inferred that the author deemed the formula $\frac{v}{V} = \frac{h}{H}$ applicable to such heights as those considered in my paper.

On his own showing, however, this formula succeeds no better than mine on Arthur's Seat; while mine possesses the unquestionable advantage of approximating to the truth throughout the higher levels, where all Mr. Stevenson's formulæ fail according to Vettin's data. If the data furnished from Arthur's Seat correctly represent the conditions in a free atmosphere up to the same level, which I very much doubt; we must infer that the velocities increase in a more rapid ratio with the heights than that given by the formula $\frac{v}{V} = \left(\frac{h}{H}\right)^{\frac{1}{2}}$, which is preferred by Mr. Stevenson, but in not so rapid a one as that given by $\frac{v}{V} = \frac{h}{H}$; and in fact, if we make the index $\frac{2}{3}$ instead of $\frac{1}{2}$, we get a formula which gives far better results, as far as the Arthur's Seat observations are concerned, than that preferred by Mr. Stevenson. The agreement is so close for nearly all the velocities, that I give below a comparison of the results afforded by both formulæ :—

Velocity recorded at high elevation, 775 feet above sea-level.	Velocities computed for lower station		Velocity recorded at lower station, 550 feet above sea-level.
	By Mr. Stevenson's formula $\frac{v}{V} = \left(\frac{h}{H}\right)^{\frac{1}{2}}$	By the formula $\frac{v}{V} = \left(\frac{h}{H}\right)^{\frac{2}{3}}$	
885	703 [1]	704	720
1,698	1,430	1,351	1,364
2,620	2,206	2,084	2,133
3,416	2,876	2,718	2,718
4,328	3,646	3,443	3,465
5,575	4,697	4,435	4,592
6,763	5,698	5,381	5,640
8,035	6,765	6,393	6,782
9,368	7,893	7,453	7,862
10,820	9,115	8,609	8,765
12,410	10,455	9,874	9 789
13,700	11,542	10,900	10,639
15,058	12,687	11,980	11,680
Sums	79,713	76,325	76,149
Means	6,132	5,871	5,857

[1] This value is wrong as given by Mr. Stevenson. It should be 745